APPENDIX D

PEKIN LAKE SOUTHERN UNIT CRITICAL RESTORATION PROJECT

HYDROLOGIC AND HYDRAULIC ANALYSES

March 10, 2004

This report summarizes the hydrologic and hydraulic analyses conducted in support of the proposed restoration of Pekin Lake, a complex of backwater lakes along the Illinois River immediately downstream of Peoria Lock and Dam and adjacent to the communities of Pekin, North Pekin, and Marquette Heights (Figure D-1). Restoration of the Southern Unit involves creating deepwater habitat within Soldwedel Lake and/or Lake of the Woods by dredging portions of these lakes; a portion of the dredged material may be placed on upland portions of the site. The project would be located along the left floodplain of the river between River Miles (RM) 153.0 and 154.7. River Miles refers to the approximately 345 navigable miles of the Illinois River. River Mile 1 is at the confluence of the Illinois and Mississippi Rivers and RM 345 at Lake Michigan. An additional restoration project, addressing the Northern Unit, would involve construction of a levee to allow water level control within the Worley Lake and Slim Lake areas. That project is addressed in a separate report.

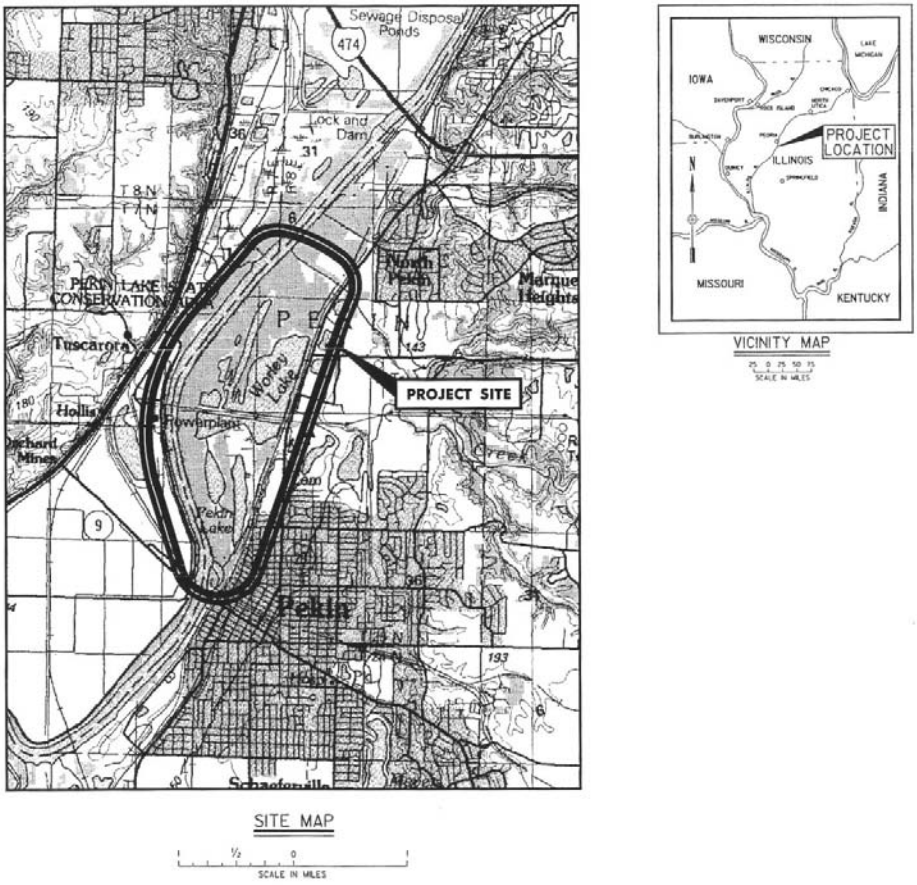

Figure D-1. Project Site and Vicinity Maps.

The hydrologic conditions in the Pekin Lake project area are largely determined by the Illinois River water level. River water enters the system through a natural outlet at the southern end of the site when river water surface elevations exceed elevation 431 feet National Geodetic Vertical Datum (NGVD). It also enters the lakes via overland flood flow when the river elevation exceeds approximately 440 feet NGVD. Lick Creek once fed the lakes in this area, but between 1904 and 1939 the creek was channelized to flow directly into the Illinois River; currently very little drainage area contributes to direct runoff into the lakes. Regional groundwater discharges into the Illinois River and the project area may intercept some of the groundwater flow. The other sources of water to the site are direct precipitation on the lakes and an unquantified but presumably small amount of local drainage.

The combination of the lack of upland runoff and the configuration of the outlet to the river may have led to lower sediment inputs to this area than experienced in other Illinois River backwater lakes. Sediment-bearing upland runoff is not a concern, and any groundwater or precipitation contributions would have little sediment. When water levels in the Illinois River are lower than 440 feet NGVD, on average 74% of the year, river inflows occur only through the constricted outlet at the south end of the site. As the river rises, water backs up through this outlet, which reduces flow velocities and the ability to transport sands and larger-grained sediments. However, when the river exceeds the bankfull level of 440 feet NGVD flood flows enter the site and introduce an unquantified but presumably large load of sediment. Analyses conducted for this project indicate that sedimentation occurs at a rate of 0.2 to 0.3 inches per year on this site; however, these rates are similar to observations in other Illinois River backwater lakes, suggesting that Pekin Lake is fairly typical in terms of sediment trapping.

Water levels prior to 1936 were generally higher than currently experienced due to control of the Illinois River and changes on the site. The Copperas Creek Dam maintained low river water levels at the site at or above 435 feet NGVD from the time it was constructed in the late 1870's until it was removed in 1936. The current dams at La Grange and Peoria maintains even lower water levels in this area because the pool of La Grange dam is maintained 6 feet lower (429 feet NGVD) than was the pool of the Copperas Creek dam. Also, a small dam had been constructed across the outlet with the river to improve commercial ice production in Pekin Lake (now called Soldwedel Lake). The combination of the flows from Lick Creek, the higher river water levels and the dam across the outlet combined to maintain higher water levels on the site in the early 20^{th} century.

Flood Profiles

Because dredge material will be placed in the floodplain, a hydraulic impact assessment was completed to determine the potential effects of the material placement. The State of Illinois regulations for construction in river floodways requires that the cumulative effects of existing construction activities do not significantly increase water levels and do not cause erosive flow velocities. A steady state hydraulic model Hydrologic Engineering Center – River Analysis System (HEC-RAS) of the river from RM 149.3 to the tailwater area of Peoria Dam at RM 157.7 was used to assess project effects. The model uses the cross-sections from the one-dimensional unsteady state flow (UNET) model that was used to calculate the 1993 published Illinois River Water Surface Profiles. The cross-sections were modified slightly to improve the conveyance ratios between cross-sections, which improves model stability.

This hydraulic analysis considers a maximum potential impact scenario where both potential restoration projects are on the Pekin Lake site. The Northern Unit and the Southern Unit

Restorations are enacted and all potential placement sites are utilized. The placement sites included in the analysis are shown on Plate D-1. The modeled cross sections representing these placement sites are given in Figures D-2 through D-5.

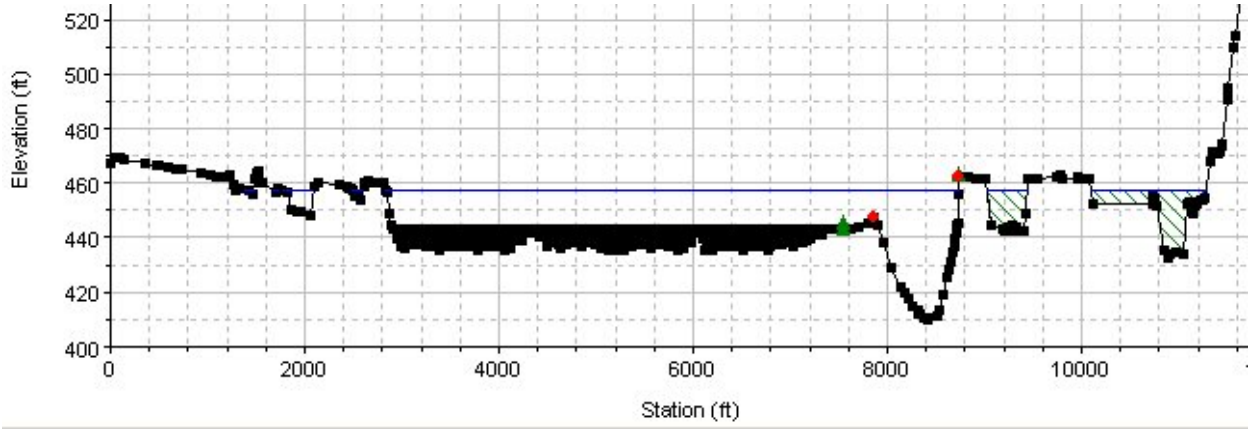

Figure D-2. River Mile 154.6 modeled cross-section. Facing downstream, black fill represents dredged material placement, Central Illinois Light Company (CILCO) causeway to elevation 444 ft, thin line represents the 100-year flood elevation at 457.27 ft.

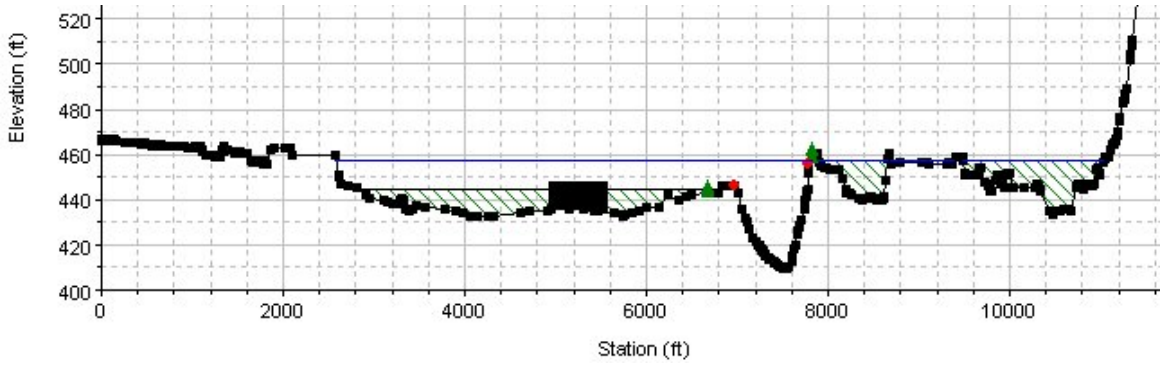

Figure D-3. River Mile 154.4 modeled cross-section. Facing downstream, black fill represents dredged material placement to elevation 448 ft, thin line represents the 100-year flood elevation at 457.25 ft.

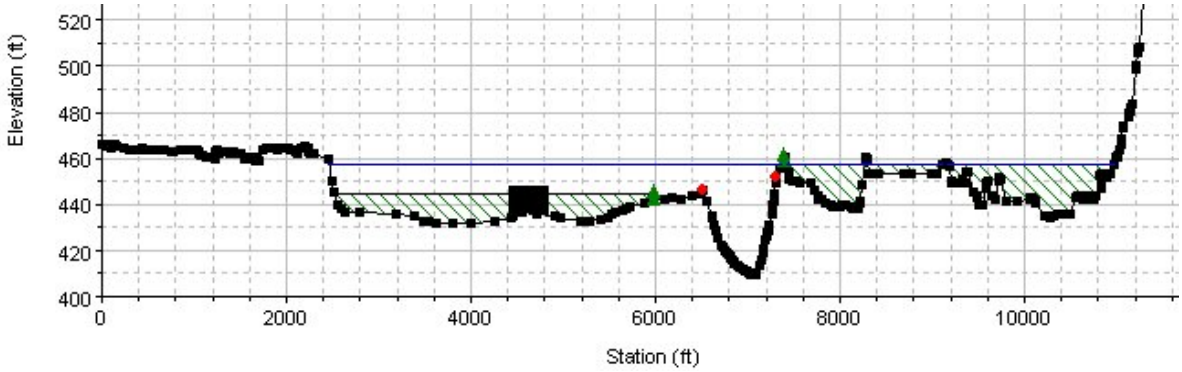

Figure D-4. River Mile 154.2 modeled cross-section. Facing downstream, black fill represents dredged material placement to elevation 448 ft, thin line represents the 100-year flood elevation at 457.24 ft.

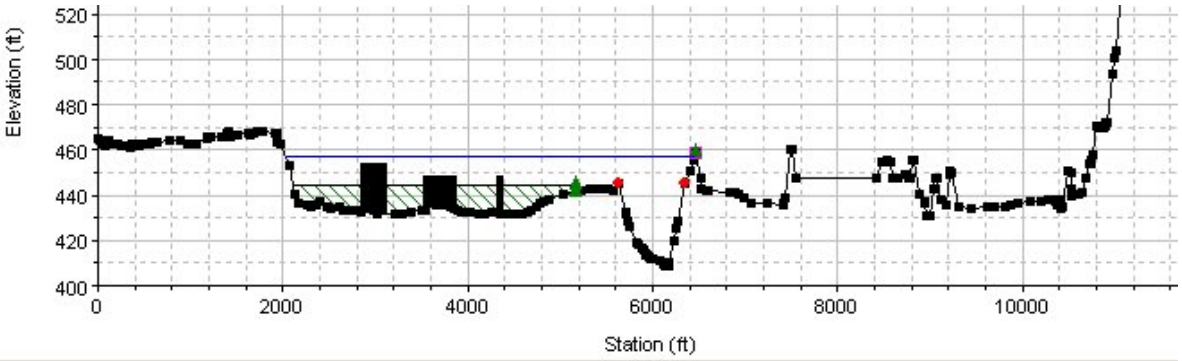

Figure D-5. River Mile 154.1 modeled cross-section. Facing downstream, black fill represents dredged material placement to elevations 454 ft, 445 ft, and 446 ft, thin line represents the 100-year flood elevation at 457.22 ft.

Five profiles were studied: the 1% flow, the flow causing overtopping of the CILCO causeway (elevation 444.0 at RM 154.6), the flow causing overtopping of the embankment dredged material placement sites (elevation 449.0 at RM 154.2), the flow causing overtopping of the ridge (elevation 453.0 at RM 154.2) and the flow causing overtopping of the island (elevation 454.0 at RM 153.94). Two conditions were modeled: with and without dredged material placement (shown in Figures D-2 through D-5). The model used the 1993 published Illinois flood profiles to estimate the downstream elevation boundary condition and the upstream flow boundary condition for each of the profiles. Boundary Conditions are listed in Table D-1 below:

Table D-1. HEC-RAS Boundary Conditions

Illinois River Discharge (cfs)	Elevation at Downstream extent of HEC-RAS model (ft NGVD)
85,000	456.7
40,000	443.3
49,000	448.6
66,000	452.5
74,000	453.4

Storage conditions impact water surface elevations because this reach of the river is very flat. Hence there are a number of combinations of starting elevation and flow that could be used to show the overtopping condition of the dredged material placement sites. The ones chosen are considered reasonable and representative of the expected impacts of this project on the river profiles.

The HEC-RAS profile elevations for the existing and with-placement site conditions are shown in Table D-2. The results indicate that the maximum change in water surface elevation from the with-placement to the existing profiles would be 0.03 ft. Also the 100-year profile would change no more than 0.01 ft, which would result in negligible impacts to the flood profiles. Also, at only one location in these profiles does the velocity in the channel or the overbank increase by more than 0.1 ft/s; at that point the modeled channel velocity was 2.4 ft/s. The velocity results indicate that erosion will not be instigated by the material placement.

Table D-2. HEC-RAS water surface profiles for Pekin Lake analysis.

River	100 year -85,000 cfs		Profile 2 - 40,000 cfs		Profile 3 - 49,000 cfs	
Mile	Existing	With project	Existing	With project	Existing	With project
157.7	457.48	457.49	444.63	444.63	449.35	449.35
157.6	457.44	457.45	444.58	444.58	449.32	449.31
157.5	457.43	457.44	444.54	444.54	449.30	449.29
157.0	457.38	457.39	444.45	444.46	449.24	449.24
156.6	457.35	457.36	444.37	444.38	449.19	449.19
156.1	457.30	457.31	444.30	444.31	449.15	449.15
155.6	457.31	457.32	444.23	444.23	449.15	449.15
155.1	457.30	457.31	444.13	444.14	449.14	449.13
154.9	457.29	457.30	444.10	444.11	449.13	449.13
154.7	457.28	457.29	444.07	444.08	449.12	449.12
154.6	457.27	457.26	444.05	444.05	449.08	449.08
154.5	457.26	457.26	444.00	444.00	449.10	449.10
154.4	457.25	457.25	443.96	443.96	449.09	449.08
154.2	457.24	457.24	443.93	443.93	449.08	449.06
154.1	457.23	457.22	443.90	443.90	449.07	449.05
153.9	457.22	457.22	443.92	443.92	449.05	449.05
153.6	457.18	457.18	443.87	443.87	449.01	449.01
153.3	457.10	457.10	443.81	443.81	448.96	448.96
152.8	457.03	457.03	443.74	443.74	448.92	448.92
152.2	456.98	456.98	443.68	443.68	448.87	448.87
151.7	456.94	456.94	443.63	443.63	448.83	448.83
151.2	456.89	456.89	443.58	443.58	448.79	448.79
150.8	456.86	456.86	443.55	443.55	448.77	448.77
150.2	456.76	456.76	443.45	443.45	448.69	448.69
149.7	456.72	456.72	443.40	443.40	448.66	448.66
149.6	456.71	456.71	443.38	443.38	448.65	448.65
149.3	456.70	456.70	443.30	443.30	448.60	448.60

Table D-2 (continued). **HEC-RAS water surface profiles for Pekin Lake analysis.**

River	Profile 4 - 66,000 cfs		Profile 5 - 74,000 cfs	
Mile	Existing	With project	Existing	With project
157.7	453.31	453.33	454.29	454.32
157.6	453.26	453.29	454.24	454.27
157.5	453.25	453.28	454.23	454.26
157.0	453.19	453.22	454.17	454.20
156.6	453.15	453.17	454.12	454.15
156.1	453.10	453.13	454.07	454.10
155.6	453.11	453.14	454.08	454.10
155.1	453.09	453.12	454.06	454.09
154.9	453.09	453.11	454.06	454.08
154.7	453.08	453.10	454.05	454.06
154.6	453.07	453.06	454.04	454.03
154.5	453.06	453.07	454.04	454.04
154.4	453.05	453.05	454.02	454.02
154.2	453.04	453.03	454.01	454.01
154.1	453.03	453.02	454.00	453.99
153.9	453.02	453.02	453.99	453.99
153.6	452.97	452.97	453.94	453.94
153.3	452.91	452.91	453.87	453.87
152.8	452.85	452.85	453.79	453.79
152.2	452.79	452.79	453.73	453.73
151.7	452.75	452.75	453.68	453.68
151.2	452.71	452.71	453.63	453.63
150.8	452.68	452.68	453.60	453.60
150.2	452.59	452.59	453.50	453.50
149.7	452.55	452.55	453.45	453.45
149.6	452.54	452.54	453.44	453.44
149.3	452.50	452.50	453.40	453.40

Water Level Analysis

Because the project site is located between the Peoria Lock and Dam and the Kingston Mines gage on the Illinois River, it is possible to use the long-term daily water level records at those locations to construct a hypothetical gage record to estimate water level conditions at the site outlet to the river. Figure D-6 shows the median annual hydrograph at the Pekin Lake outlet based on 62 years of Illinois River water level records (WY 1939-2001). Also shown are the 90% and 10% daily exceedance water levels, which correspond to the low and high water levels, respectively, expected to occur once every ten years for each particular day. This figure shows

that the site is generally flooded from late March through late May, but that there is at least a 10% chance that it will be flooded on any day of the year except from late July until November.

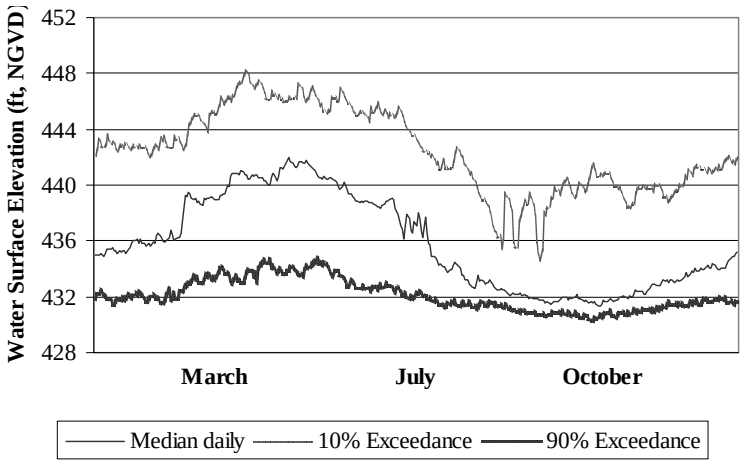

Figure D-6. Illinois River daily water level at River Mile 153.

The average annual high water level is 446.8 feet NGVD, and the 90% and 10% annual exceedances are 442.7 and 452.1 feet NGVD, indicating that the site is generally flooded at some point of the year even during the 10-year low-flow year. The average, 90% and 10% annual exceedance low-water levels are 430.5, 429.8, and 431.2 feet NGVD, indicating that the site draws down nearly every year so that the surface water outlet to the river goes dry.

This water level analysis was used to establish the desirable depths for dredging. Since the most restrictive requirement for habitat benefits was the provision of overwintering fish habitat, the bottom elevation necessary for adequate overwintering depth (at least 6 feet) was analyzed. At Pekin Lake, freezing conditions necessitating deepwater refuge generally occur between December and February. Water levels in Pekin Lake exceed 432 feet NGVD approximately 90% of the time during those months (see Figure D-6), so given the design assumption of 2 feet of sedimentation over a 50-year project life, excavation to 424 feet NGVD would provide adequate overwintering depth at least 90 percent of the time throughout the project life.